

demonstrate compliance with the applicable standards.

(c) *Procedure.* Use the following linearity verification protocol, or use good engineering judgment to develop a different protocol that satisfies the intent of this section, as described in paragraph (a) of this section:

(1) In this paragraph (c), the letter “y” denotes a generic measured quantity, the superscript over-bar denotes an arithmetic mean (such as \bar{y}), and the subscript “ref” denotes the known or reference quantity being measured.

(2) Operate a dynamometer system at the specified temperatures and pressures. This may include any specified adjustment or periodic calibration of the dynamometer system.

(3) Set dynamometer speed and torque to zero and apply the dynamometer brake to ensure a zero-speed condition.

(4) Span the dynamometer speed or torque signal.

(5) After spanning, check for zero speed and torque. Use good engineering judgment to determine whether or not to rezero or re-span before continuing.

(6) For both speed and torque, use the dynamometer manufacturer’s recommendations and good engineering judgment to select reference values, y_{refi} , that cover a range of values that you expect would prevent extrapolation beyond these values during emission testing. We recommend selecting zero speed and zero torque as reference values for the linearity verification.

(7) Use the dynamometer manufacturer’s recommendations and good en-

gineering judgment to select the order in which you will introduce the series of reference values. For example, you may select the reference values randomly to avoid correlation with previous measurements or the influence of hysteresis; you may select reference values in ascending or descending order to avoid long settling times of reference signals; or you may select values to ascend and then descend to incorporate the effects of any instrument hysteresis into the linearity verification.

(8) Set the dynamometer to operate at a reference condition.

(9) Allow time for the dynamometer to stabilize while it measures the reference values.

(10) At a recording frequency of at least 1 Hz, measure speed and torque values for 30 seconds and record the arithmetic mean of the recorded values, \bar{y}_i . Refer to 40 CFR 1065.602 for an example of calculating an arithmetic mean.

(11) Repeat the steps in paragraphs (c)(8) through (10) of this section until you measure speeds and torques at each of the reference conditions.

(12) Use the arithmetic means, \bar{y}_i , and reference values, y_{refi} , to calculate least-squares linear regression parameters and statistical values to compare to the minimum performance criteria specified in Table 1 of this section. Use the calculations described in 40 CFR 1065.602. Using good engineering judgment, you may weight the results of individual data pairs (*i.e.*, $(y_{\text{refi}}, \bar{y}_i)$), in the linear regression calculations.

TABLE 1 OF § 1066.220—DYNAMOMETER MEASUREMENT SYSTEMS THAT REQUIRE LINEARITY VERIFICATIONS

Measurement system	Quantity	Linearity criteria	a_1	SEE	r^2
		$ x_{\text{min}}(a_1 - 1) + a_0 $			
Speed	S	$\leq 0.05\% \cdot S_{\text{max}}$	0.98–1.02	$\leq 2\% \cdot S_{\text{max}}$	≥ 0.990
Torque (load)	T	$\leq 1\% \cdot T_{\text{max}}$	0.98–1.02	$\leq 2\% \cdot T_{\text{max}}$	≥ 0.990

§ 1066.225 Roll runout and diameter verification procedure.

(a) *Overview.* This section describes the verification procedure for roll runout and roll diameter. Roll runout is a measure of the variation in roll radius around the circumference of the roll.

(b) *Scope and frequency.* Perform these verifications upon initial installation and after major maintenance.

(c) *Roll runout procedure.* Verify roll runout as follows:

(1) Perform this verification with laboratory and dynamometer temperatures stable and at equilibrium. Release the roll brake and shut off power to the dynamometer. Remove any dirt, rubber, rust, and debris from the roll surface. Mark measurement locations on the roll surface using a permanent marker. Mark the roll at a minimum of four equally spaced locations across the roll width; we recommend taking measurements every 150 mm across the roll. Secure the marker to the deck plate adjacent to the roll surface and slowly rotate the roll to mark a clear line around the roll circumference. Repeat this process for all measurement locations.

(2) Measure roll runout using a dial indicator with a probe that allows for measuring the position of the roll surface relative to the roll centerline as it turns through a complete revolution. The dial indicator must have a magnetic base assembly or other means of being securely mounted adjacent to the roll. The dial indicator must have sufficient range to measure roll runout at all points, with a minimum accuracy and precision of ± 0.025 mm. Calibrate the dial indicator according to the instrument manufacturer's instructions.

(3) Position the dial indicator adjacent to the roll surface at the desired measurement location. Position the shaft of the dial indicator perpendicular to the roll such that the point of the dial indicator is slightly touching the surface of the roll and can move freely through a full rotation of the roll. Zero the dial indicator according to the instrument manufacturer's instructions. Avoid distortion of the runout measurement from the weight of a person standing on or near the mounted dial indicator.

(4) Slowly turn the roll through a complete rotation and record the maximum and minimum values from the dial indicator. Calculate runout as the difference between these maximum and minimum values.

(5) Repeat the steps in paragraphs (c)(3) and (4) of this section for all measurement locations.

(6) The roll runout must be less than 0.25 mm at all measurement locations.

(d) *Diameter procedure.* Verify roll diameter based on the following procedure,

or an equivalent procedure based on good engineering judgment:

(1) Prepare the laboratory and the dynamometer as specified in paragraph (c)(1) of this section.

(2) Measure roll diameter using a Pi Tape®. Orient the Pi Tape® to the marker line at the desired measurement location with the Pi Tape® hook pointed outward. Temporarily secure the Pi Tape® to the roll near the hook end with adhesive tape. Slowly turn the roll, wrapping the Pi Tape® around the roll surface. Ensure that the Pi Tape® is flat and adjacent to the marker line around the full circumference of the roll. Attach a 2.26-kg weight to the hook of the Pi Tape® and position the roll so that the weight dangles freely. Remove the adhesive tape without disturbing the orientation or alignment of the Pi Tape®.

(3) Overlap the gage member and the vernier scale ends of the Pi Tape® to read the diameter measurement to the nearest 0.01 mm. Follow the manufacturer's recommendation to correct the measurement to 20 °C, if applicable.

(4) Repeat the steps in paragraphs (d)(2) and (3) of this section for all measurement locations.

(5) The measured roll diameter must be within ± 0.25 mm of the specified nominal value at all measurement locations. You may revise the nominal value to meet this specification, as long as you use the corrected nominal value for all calculations in this subpart.

§ 1066.230 Time verification procedure.

(a) *Overview.* This section describes how to verify the accuracy of the dynamometer's timing device.

(b) *Scope and frequency.* Perform this verification upon initial installation and after major maintenance.

(c) *Procedure.* Perform this verification using one of the following procedures:

(1) *WWV method.* You may use the time and frequency signal broadcast by NIST from radio station WWV as the time standard if the trigger for the dynamometer timing circuit has a frequency decoder circuit, as follows:

(i) Dial station WWV at (303) 499-7111 and listen for the time announcement.